BOCK KÄLTEMASCHINEN

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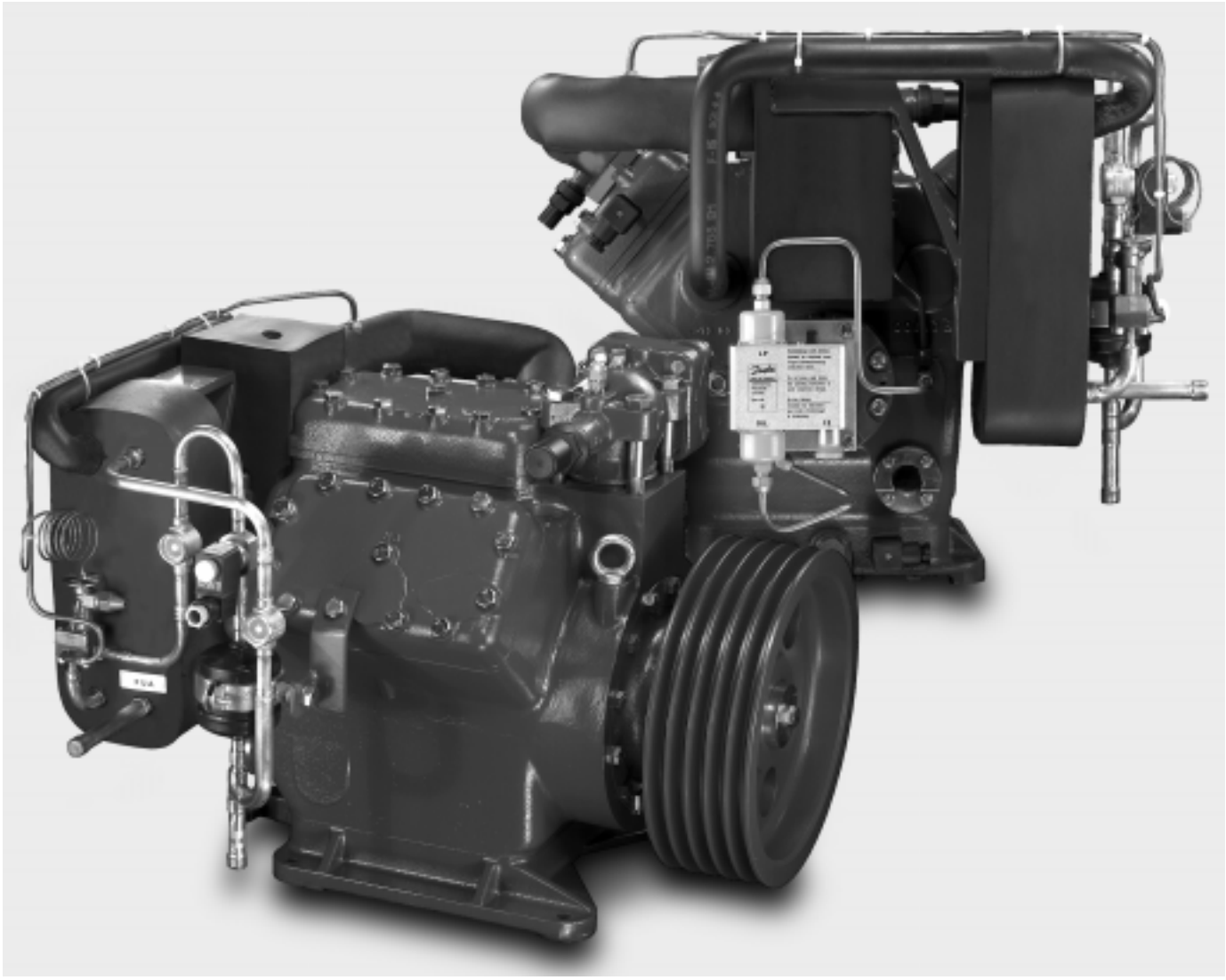
Page 1

Operating instructions
Open two-stage compressor FZ 16

Type: FZ 16 / 2051- R 22
FZX 16 / 2051- R 404 A
FZX 16 / 2051- R 410 A



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QUALITY SYSTEM

certified by DQS according to
DIN EN ISO 9001 Reg. No. 2177

CERTIFIED IQNet MANAGEMENT SYSTEM

Subject to change without notice.

1. Safety instructions

- Only qualified staff are allowed to handle refrigerating compressors. Local safety regulations, accident prevention regulations, technical rules etc. must be observed.
- **Caution!**
  The compressor is under pressure (inert gas).
  Relieve the pressure before connecting up to the refrigerating system or before starting any work on this machine.
- Note the max. permissible operating pressure (see nameplate).
- These instructions describe the FZ 16 compressor in the standard version.
- If you have any queries, please contact our technical service department phone 07022-9454-0, or speak to our representative.

2. Open two-stage compressor FZ 16

The FZ-16 compressor by BOCK is a two-stage open reciprocating compressor with intermediate cooling for economic use in the extended deep-cooling range. Depending on the refrigerant used, evaporation temperatures of down to t_0 = -65°C are possible.

The advantages compared to single-stage compression include, among others:

- Low discharge end temperatures.
- Favourable pressure conditions and thus low load on the power plant and valve system.
- Low specific power requirements and other low operating costs.

3. Brief description

- Open, two-stage six-cylinder reciprocating compressor.
- Cylinders arranged in W-shape.
- Operates with the counterflow principle.
- Automatic lamella inlet and outlet valves in the cylinder heads.
- Valve plate specially tuned on the high pressure side.
- Displacement ratio low-pressure stage to high pressure stage = 2:1.
- Intermediate cooling with panel heat exchanger for effective reduction of the discharge end temperature on the high pressure side.
  The panel heat exchanger and all components required for intermediate cooling are completely mounted on the compressor with all pipes connected.
- There are 3 compressor versions depending on the refrigerant being used, with differences in the injection valves:

for R 22	FZ 16 / 2051 – R22	Art. No. 11730
for R 404 A	FZX 16 / 2051 – R 404 A	Art. No. 11728
for R 410 A	FZX 16 / 2051 – R 410 A	Art. No. 11729

The injection valve version is indicated by the refrigerant type in the compressor type designation, e.g. FZ 16 / 2051 – R22.

4. Main and function parts

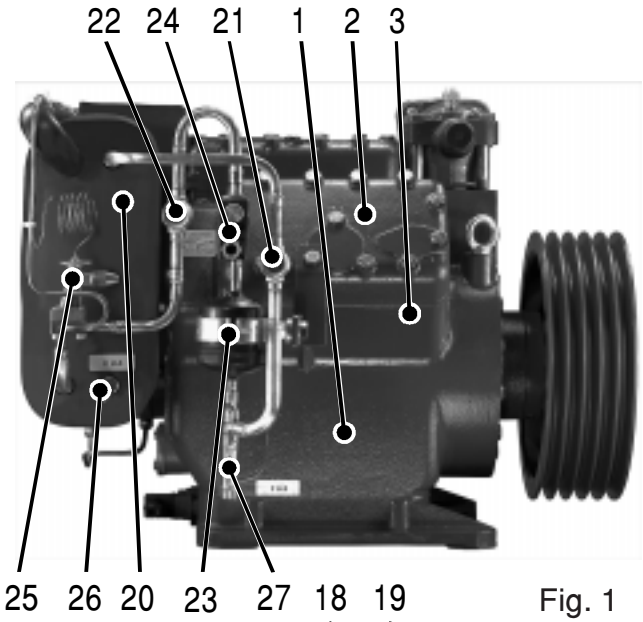


Fig. 1

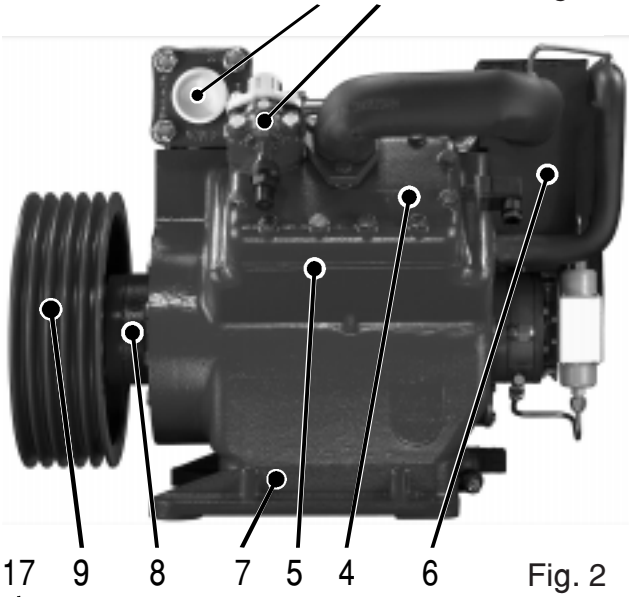


Fig. 2

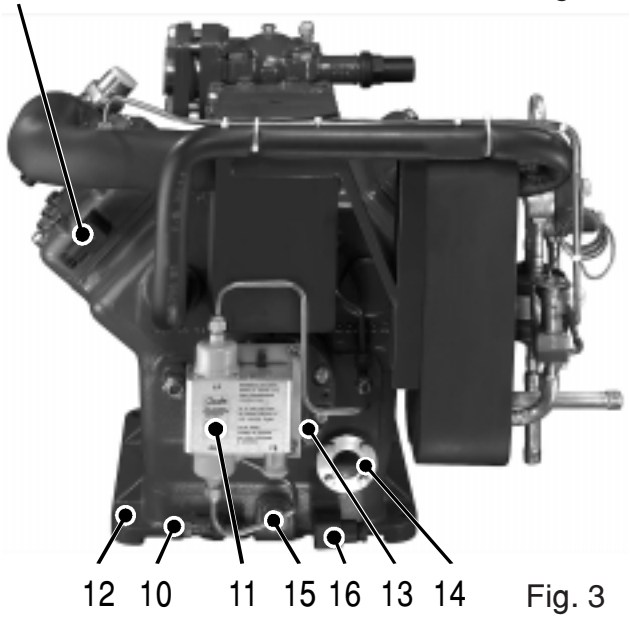


Fig. 3

1. Compressor housing
2. Cylinder cover low pressure side (LP)
3. Valve plate low pressure side (LP)
4. Cylinder cover high pressure side (HP)
5. Valve plate high pressure side (HP)
6. Middle pressure chamber
7. Base plate
8. Shaft seal
9. Compressor belt pulley
10. Oil drain valve
11. Oil pressure safety switch
12. Oil intake plug
13. Oil pump
14. Oil sight glass
15. Oil filter
16. Oil sump heating
17. Heat protection thermometer
18. Suction shut-off valve SV
19. Pressure shut-off valve DV
20. Intermediate cooler
21. Sight glass 1 liquid pipe
22. Sight glass 2 liquid pipe
23. Filter dryer
24. Solenoid valve
25. Expansion valve
26. Intermediate cooler – inlet
27. Intermediate cooler – outlet

5. Nameplate

The following information is contained on the compressor nameplate:

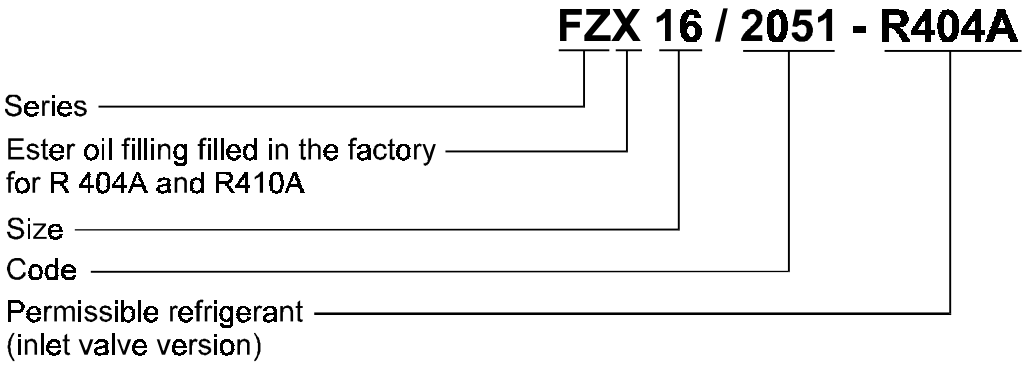
Fig. 4

1. Type designation with refrigerant
2. Machine number
3. Year of construction
4. Minimum speed
5. Maximum speed
6. Theoretical volume flow rate low pressure stage at 1450 rpm
7. Theoretical volume flow rate high pressure stage at 1450 rpm
8. Max. permissible operating overpressures
   (HP = pressure side / LP = suction side) [1)]
9. Grade of oil filled in the factory

[1)] The stated pressure and suction overpressures are not maximum values referred to the refrigerant. The corresponding limits of application stated on page 6 – 7 apply to the various refrigerants.

6. Type key

(example)



7. Limits of application

7.1 Absolute limits of application

Discharge end temperature $t_{v2, max.}$ = 140°C

Speeds $n_{min.}$ = 1400 rpm
$n_{max.}$ = 1800 rpm

Max. permissible operating overpressure
Pressure side HP = 25 bar
Suction side LP = 19 bar

7.2 Limits of application FZ 16 / 2051 - R 22

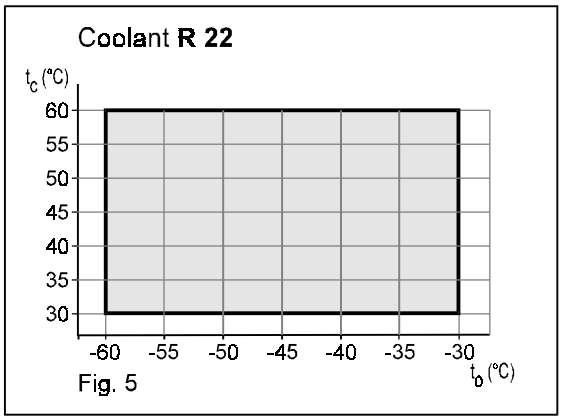


Fig. 5

$t_{o, min.}$ = - 60°C
$t_{c, max.}$ = + 60°C

7.3 Limits of application FZX 16 / 2051 - R 404 A

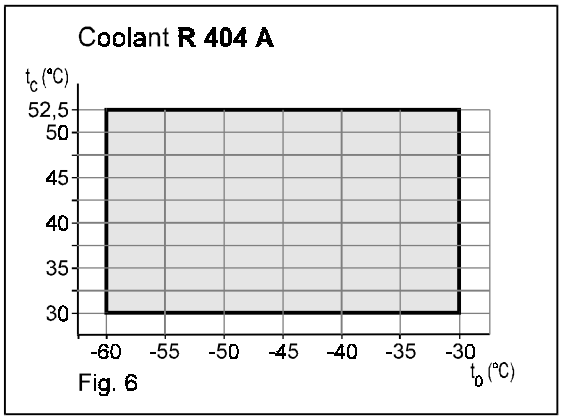


Fig. 6

$t_{o, min.}$ = - 60°C
$t_{c, max.}$ = + 52,5°C

7.4 Limits of application FZ 16 / 2051 - R 410 A

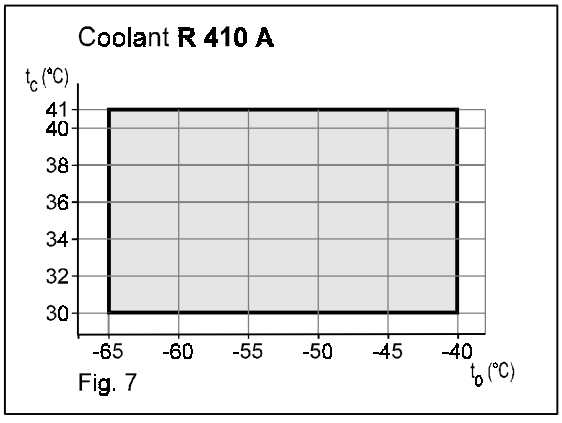


Fig. 7

$t_{o, min.}$ = - 65°C
$t_{c, max.}$ = + 41°C

Definitions
t_o = evaporation temperature
t_c = condensing temperature

Explanations for figs. 5 to 7:

Compressor FZ 16 / 2051 may only be operated within the range of the illustrated diagrams.
Correct allocation of the refrigerants must be observed:
FZ 16 / 2051 - R 22 may only be operated with R 22
FZX 16 / 2051 - R 404 A may only be operated with R 404 A
FZX 16 / 2051 - R 410 A may only be operated with R 410 A.
The “absolute limits of application“ stated in 7.1 must be observed.

As a general rule:

- The compressor is equipped with heat protection thermostats as a standard feature, **connection is recommended.**
- Use only thermally highly stable oils (see extract from the lubricant table, pate 17, table 2).

Recommendation:

for R 22:	Bock standard oil FUCHS DEA RENISO SP 46
for R 404 A and R 410 A:	Bock standard oil FUCHS DEA RENISO TRITON SE 55

- Continuous operation at the limit is not recommended
  Note:
  The expansion valve (position 25, fig. 1) of the intermediate cooler is rated for the corresponding refrigerant (see nameplate) and adjusted in the factory for the whole application range. Re-adjustment is not necessary.

8. Description of functions FZ 16 / 2051 (see fig. 8, page 8)

The refrigerant sucked out of the evaporator (21) is compressed by the 4 cylinders on the LP stage (2) to the intermediate pressure p_z. The overheated refrigerant then flows through the intermediate pressure chamber (3) where it is cooled down by an intermediate cooling system to reduce the discharge end temperature.

The intermediate cooling system consists of the following components:

- intermediate cooler (6)
- expansion valve (7)
- sight glass 1 (8) and 2 (9) of the liquid pipe
- solenoid valve (10)
- filter drier (11)

The cooled refrigerant is then sucked in through the intermediate pressure pipe (4) by the two cylinders of the HP stage (5), compressed to end pressure and conveyed to the condenser (15).

After the refrigerant receiver (16), the liquid pipe divides into two pipes:

Pipe 1 goes through the panel heat exchanger (6) and brings the sub-cooled refrigerant to the evaporator (21).

Pipe 2 refrigerant is injected into the panel heat exchanger (6) via the expansion valve (7) to sub-cool the refrigerant here in pipe 1 and then cool down the overheated refrigerant of the low pressure stage in the intermediate pressure chamber (3), which has been compressed to the intermediate pressure p_z.

8.1 Diagram to show a refrigerating plant with two-stage compressors FZ 16 / 2051

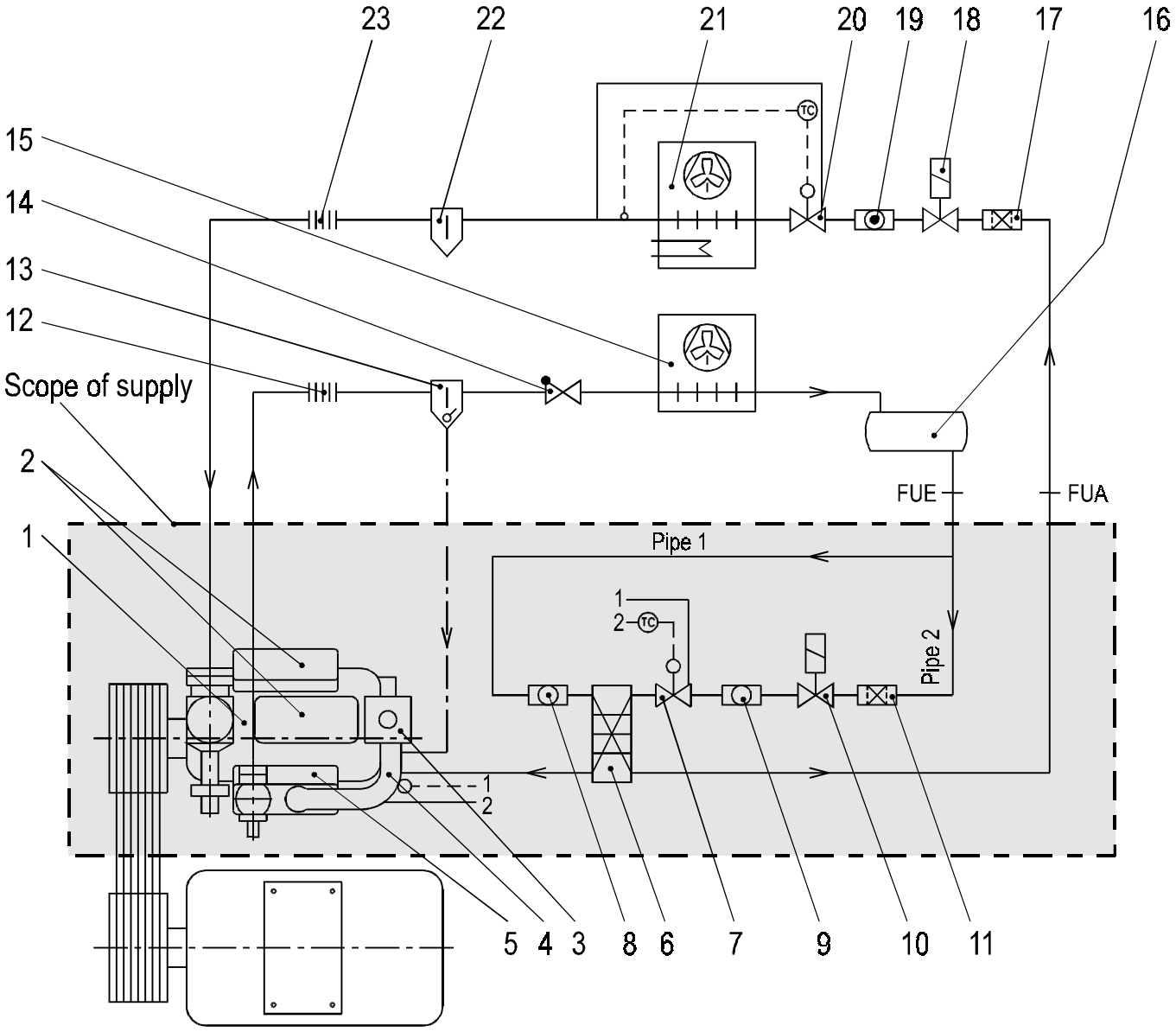


Fig. 8

1. Compressor
2. Cylinder LP stage
3. Intermediate pressure chamber
4. Intermediate pressure pipe
5. Cylinder HP stage
6. Panel heat exchanger
7. Expansion valve
8. Sight glass 1
9. Sight glass 2
10. Solenoid valve
11. Filter drier
12. Anti-vibration pads pressure pipe

} *1)

13. Oil separator
14. Non-return valve
15. Condenser
16. Refrigerant receiver
17. Filter drier
18. Solenoid valve
19. Sight glass
20. Expansion valve (evaporator)
21. Evaporator
22. Liquid separator
23. Anti-vibration pads suction pipe

FUE Liquid intermediate cooler, inlet
FUA Liquid intermediate coller, outlet

*1) components for the intermediate cooling system, standard feature in scope of supply.

9. Installation instructions

9.1 General

- Compressor and motor mounted rigid on joint base frame. Anti-vibration pads (rubber pads) used for erection of base frame on foundation.
- Leave sufficient space for maintenance work.
- Mount the belt drive properly as follows:
  - The belt pulleys of compressor and drive motor must fit tightly and be in line.
  - Use only V-belts with calibrated length.
  - Select centre-to-centre spacing, V-belt length and belt pre-tension according to instructions provided by belt manufacturer. Avoid belt flutter.
  - Check belt pre-tension after running-in period.
- Only lift compressor at the transport eyelets (fig. 9 and 10).

Fig. 9

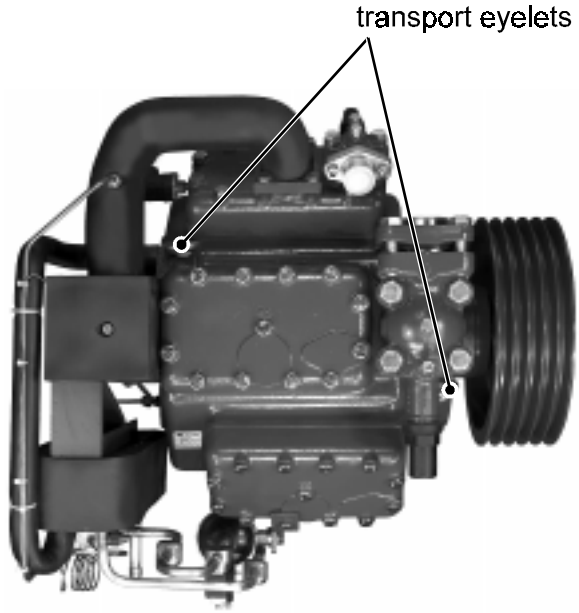


Fig. 10

9.2 Pipe connections / pipelines

Caution!
Compressor is under pressure (inert gas).
Shut-off valves should remain closed until evacuated.

Pipe connections are designed so that pipes in normal millimetre and inch dimensions can be used. The soldering nipples of the shut-off valves are to be removed from the shut-off valves when soldering the pipes.

Pipelines and plant components must be thoroughly clean and dry on the inside, and free of scales, metal chips, rust and phosphate layers. The parts must also be delivered in an air-tight seal.

Note:
All pipes are to be equipped with suitable vibration compensators.

9.3 Shut-off valves

Caution!
The two shut-off valves (suction shut-off valve and pressure shut-off valve) must be opened before starting the compressor. For location and arrangement of the valves, see page 4.

Opening the shut-off valve

a) Turn spindle 1: to the left (anti-clockwise) as far as it will go.
⇒ shut-off valve fully open / service connection 2 closed (position A), fig. 11.

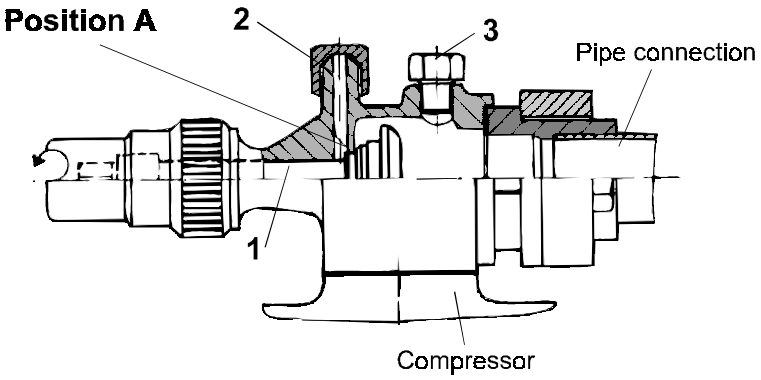


Fig. 11

Opening the service connection (2)

b) Turn the spindle 1: ½ - 1 turn to the right
⇒ service connection 2 open (shut-off valve open (position B)), fig. 12.
Service connection 3 cannot be shut off (always open).

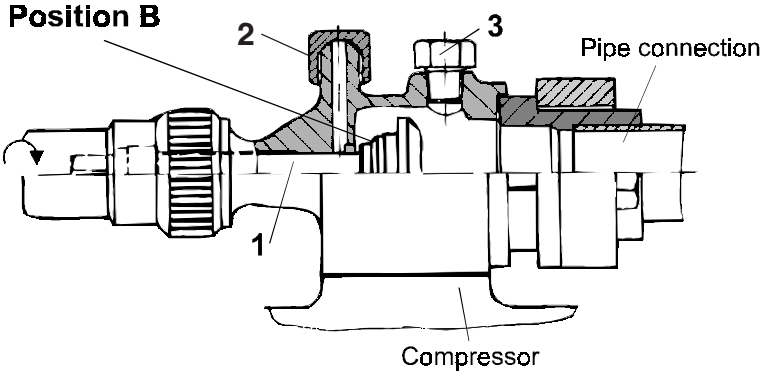
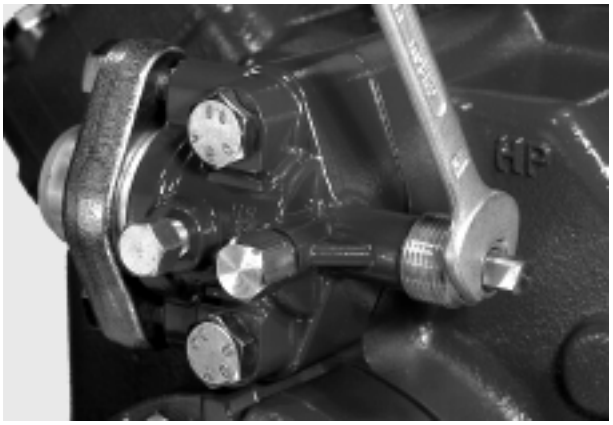


Fig. 12



Note:
Before opening or closing the shut-off valve, loosen the valve spindle seal by turning about ¼ turn. Tighten again after activating the shut-off valve (fig. 13).

Fig. 13

10. Initial commissioning

The compressor has undergone a trial run in the factory and all functions have been checked. Special running-in instructions do not need to be observed.

Caution!

The machine is under pressure (inert gas). The **pressure must be relieved** before connecting up to the refrigeration system or before any work on the machine. Depending on the operating conditions, surface temperatures of up to 100°C can be reached on the pressure side, respectively below 0°C on the suction side.

10.1 Leak test, evacuating

- Proceed with a leak test for the refrigerating plant **without including the compressor** (preferably N_2-dried).
- **Then include the compressor** in the subsequent evacuating procedure.
  (To do so, open the compressor suction side and pressure shut-off valve **"relieve pressure first"!).**
  Note:
  As well as the suction respectively high-pressure side, the middle pressure area of the compressor also has to be evacuated (use connection "X", see page 18, fig. 19).
  The solenoid valve of the intermediate cooling system (position 10, fig. 8) should be open when doing so.
- Vacuum < 1.5 mbar with pump shut off. Repeat procedure several times as required.
- Machine is then dry and tight when the rise in pressure in the refrigerating system is < 0.5 mbar/24 h with the vacuum pump switched off.

10.2 Refrigerant filling

- Check the oil level in the compressor before filling up.
  The oil level must be visible in the sight glass.
- Check once again whether the compressor suction and pressure shut-off valves are open.
- Top up the coolant (breaking the vacuum) with the machine switched off, filling the liquid straight into the condenser respectively collector.
  Note:
  Ensure there is sufficient refrigerant in the machine before initial commissioning of the compressor. Refrigerant must be visible without any bubbles in sight glasses 1 and 2 of the intermediate cooler.
- Start up the compressor. If it is necessary to top up the refrigerant after initial commissioning, this can take place either in gaseous form on the suction side or, taking suitable precautions, in liquid form at the evaporator intake.

Caution!

- **Never top up with liquid refrigerant via the suction shut-off valve on the compressor.**
- **Additives may not be added to oil and refrigerant.**

10.3 Liquid shocks

Special attention must be paid to the following to avoid liquid shocks:

- The whole refrigerating plant must be **properly designed.**
- All components must be **rated to be compatible with each other with regard to output** (particularly evaporator and expansion valve).
- Suction gas overheating at the evaporator outlet should be **min. 7 – 10 K** (check setting of the thermostatic expansion valve).
- Particularly in the case of critical plant (e.g. with several evaporator points), suitable measures are recommended, e.g. using liquid traps, solenoid valve in the liquid pipe, etc.

Caution!
Liquid shocks can cause damage to the compressor.

Important note:
In order to avoid liquid shocks on the HP side, the solenoid valve for reinjection (no. 20, see diagram page 8) may not be opened until approx. 15 – 20 seconds after switching on the compressor (full load operation).

Switching off the compressor:
Close the solenoid valve approx. 15 - 20 seconds before switching the compressor off.

10.4 Lubrication / oil check

The oil level of the compressor is to be checked immediately after the start.

- Oil level ¼ to ¾ of the sight glass (notch in sight glass = min. oil level, oil should not fall below this, fig. 14).
- Oil pressure control using a pressure gauge is possible if required via a Schrader connection at the oil pump (for connection position see page 18, fig. 19). Oil differential pressure should be 1.5 – 4.0 bar (over the whole application range).

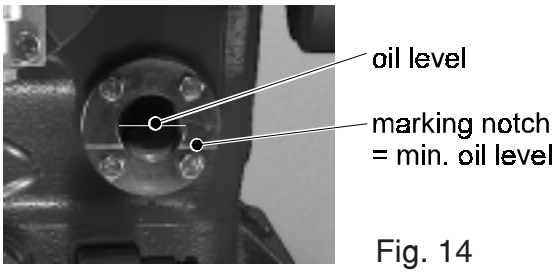


Fig. 14

- Automatic monitoring by standard oil differential pressure switch. Troubleshooting should be carried out when the machine is switched off by this device (observe instructions on the lid of the switch).

Caution!
If larger quantities of oil have to be topped up, there is a risk of liquid shocks: the oil return line must be checked.

10.5 Oil pressure safety switch

FZ 16 / 2051 is equipped with a differential pressure switch as a standard feature for automatic monitoring of the oil pressure. Electrical connection according to the enclosed description. Troubleshooting should be carried out when the machine is switched off by this device (observe instructions on the lid of the switch).

10.6 Oil sump heating

Description see also DEF-1.39 “Oil sump heating“

While the compressor is at a standstill, refrigerant diffuses into the lubricating oil of the compressor housing, depending on pressure and ambient temperature. This reduces the lubricating ability of the oil. When the compressor starts up again, the reduction in pressure causes the refrigerant contained in the oil to evaporate out again. This can result in oil foaming and oil migration, causing oil shocks under certain circumstances.
In order to avoid damage to the compressor, FZ 16 / 2051 compressors are equipped with oil sump heating as a standard feature. The oil sump heating should always be connected up and kept running.

Operation notes:
The oil sump heating is in operation during standstill of the compressor. When starting the compressor, the oil sump heating switches off.

Note:
The oil sump heating must be connected up to a separate current circuit via an auxiliary contact (or parallel wired auxiliary contactor) of the compressor contactor. It may not be connected up to the current circuit of the safety control chain.

Electrical data:
230 V ~ / 140 W

10.7 Heat protection thermostat

The FZ 16 / 2051 compressor is equipped with a bi-metal heat protection thermostat. The thermo-contact switch protects the compressor from intolerably high compressed gas temperatures. The heat protection thermostat is mounted on the hot vapour side of the compressors to the HP cylinder head.

Technical data for the heat protection thermostat:

Switching voltage	max.	250 V ~
Switching current	max.	1.6 A at 250 V ~
Switching off temperature		145 °C ± 5 K
Switching on temperature		approx. 115 °C

The thermostat is to be wired up in sequence with the control line.

10.8 Shaft seal

The compressor shaft is sealed to the outside by means of a shaft seal (page 4, fig. 2, position 8). The sealing element turns with the shaft.

The following is **particularly important** for troublefree operation:

- The entire refrigerant circuit **must be properly designed and completely clean on the inside.**
- **Extreme jolts and vibrations** on the wave are to be avoided, together with **continuous intermittent operation.**
- The sealing surfaces can stick together when the machine is at a standstill for longer periods of time. The machine should be **started up briefly every 4 weeks.**

Caution!
Failure to conform with this recommendation can cause a loss of refrigerant and damage to the shaft seal.

Note:

- The shaft seal seals off and lubricates with oil. A certain oil leak (few oil drops) is therefore normal, this applies in particular to the running-in phase (200 – 300 hours).
- The shaft seal cover is equipped with an oil drain hose for controlled removal of the leaking oil. A suitable receptacle is to be provided by the customer (fig. 15).

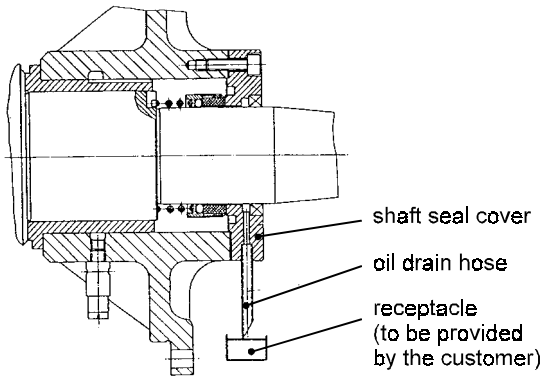


Fig. 15

- Replacement of a shaft seal is described in the corresponding spare parts kit.

11. Operation

11.1 Start unloader

The FZ 16 compressor cannot be equipped with the normal start unloader integrated in the cylinder cover. The division into LP and HP stage means that the normal start unloader, available as accessory, would only provide partial unloading in the LP stage.

External start unloading is therefore to be provided by pipes (pipe diameter 22 mm) with solenoid valve. The solenoid valve must be suitably fastened to avoid vibration fractures in the pipeline.

Caution!
The solenoid valve of the intermediate cooling system (page 8, fig. 8, position 10) must be closed when operating with start unloader!

11.2 Defrosting

To guarantee troublefree operation of the refrigerating plant, we recommend defrosting the evaporator by means of an electrical defroster device rather than using hot gas.

12. Maintenance

12.1 Safety instructions

Caution!
Before any work is carried out on the compressor:
- Switch the machine off and secure it to prevent it being switched on again.
- Relieve the system pressure in the machine.

After maintenance work has been completed:
- Connect up the safety switch and check functions.
- Evacuate the compressor.
- Remove the switching on safeguard.

12.2 Service intervals

In order to guarantee optimum operating safety and service life of the compressor, **we recommend** carrying out the following servicing tasks at regular intervals (particularly recommended in the limit range at high temperatures and pressures:)

- **Oil change:** for the first time after approx. 100 - 200 operating hours, then once every twelve months. Always clean the oil suction filter when changing the oil.
  Note:
  Used oil must be disposed of properly in line with national regulations.
- **Function checks: once every twelve months:** oil level, compressor leaks, running noises, pressures, temperatures, functioning of the additional equipment, e.g. solenoid valve in the intermediate cooling system, oil pressure safety switch, etc.

12.3 Recommended spare parts

The following table gives an overview of the most important spare parts:

Compressor type / Designation	FZ 16/2051-R22	FZX 16/2051-R404A	FZX 16/2051-R410A
	Art. No.	Art. No.	Art. No.
Gasket kit	08494		
Shaft seal kit	08012		
Kit for valve plate low pressure side LP	08498		
Kit for valve plate high pressur side HP	08499		
Oil pump kit	08795		
Oil sump heating kit 230 V ~	08426		

Tab. 1

12.4 Replacing the valve plates

The FZ compressors are divided into an LP and an HP compressing stage.
Different types of valve plates are required for the individual compressing stages because of the canal guidance.

Caution!
The valve plates of the LP and HP stage may not be confused during maintenance and repair work!

- If an LP valve plate is mounted to the HP cylinder head, the compressor is short-circuited internally and has no output.
- If an HP valve plate is mounted to one of the two LP cylinder heads, this can cause an intolerably high increase in pressure in the cylinder head – **risk of bursting!**
  The HP valve plate is therefore marked with **FZ16/1 HP stage,** and has a **locking pin dia. 5 mm. The locking pin may not be removed** and must engage in the hole of the HP cylinder head when mounting the valve plate.

LP valve plate

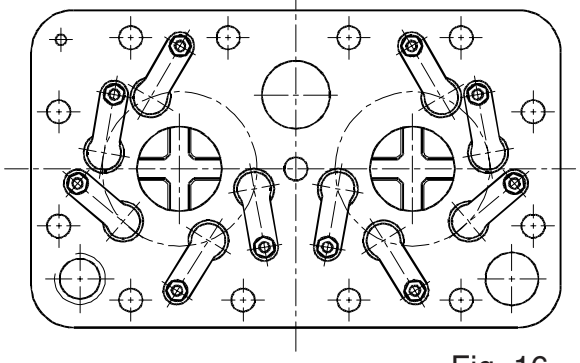


Fig. 16

HP valve plate

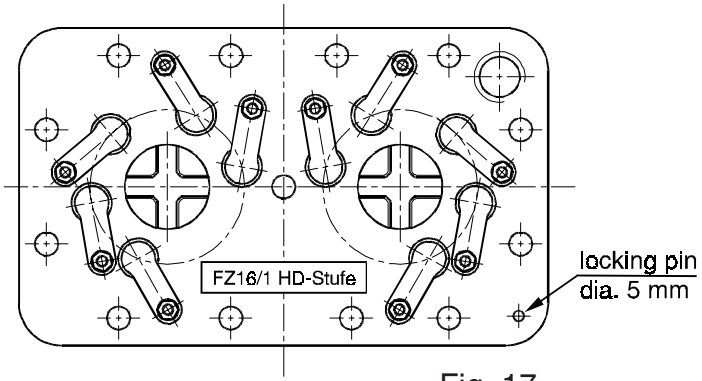


Fig. 17

- Installation position valve plates

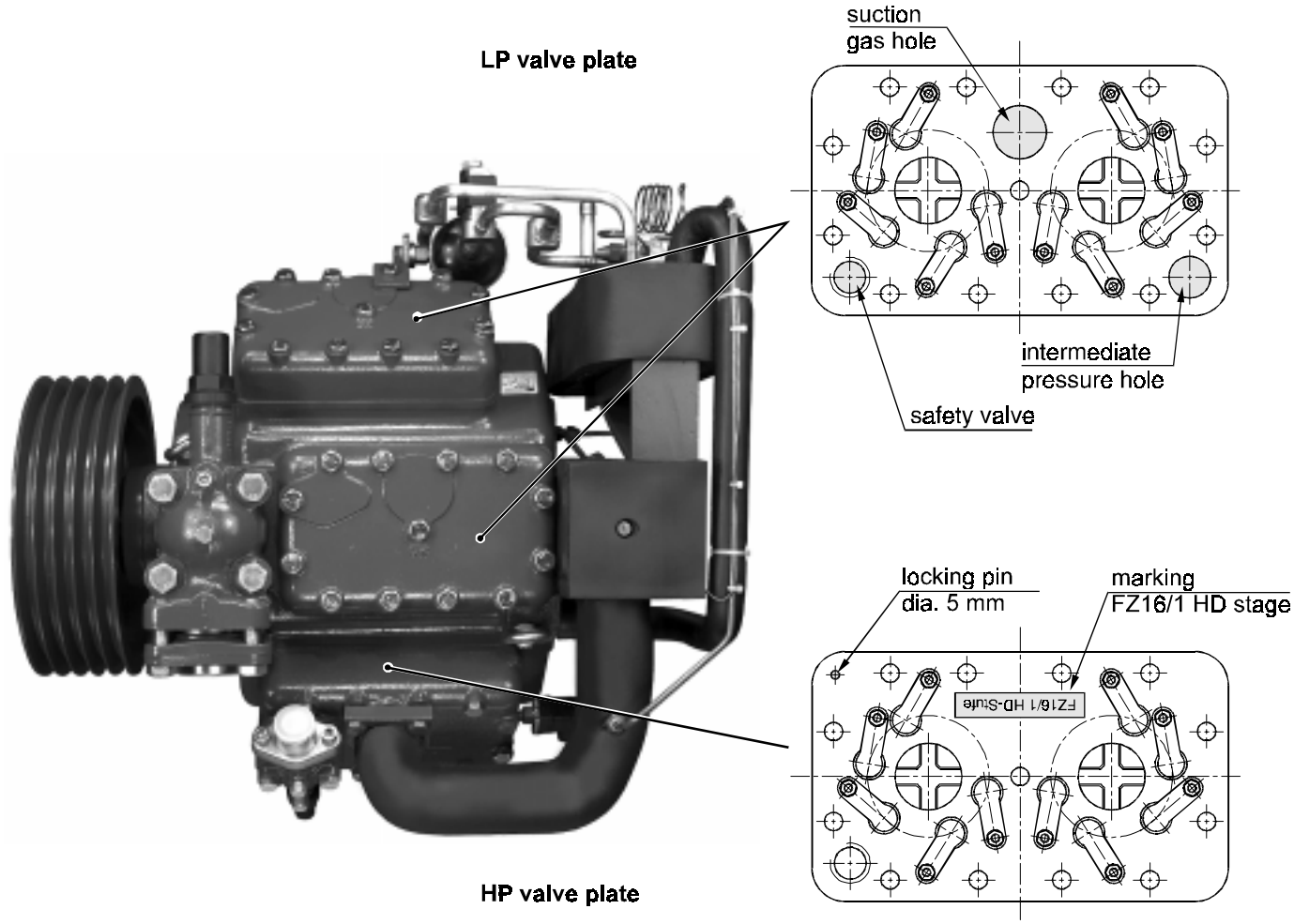


Fig. 18

12.5 Excerpt from the lubricant table

For FZ 16 / 2051 - R 22	
Bock standard oil grade	**Recommended alternatives**
FUCHS DEA Reniso SP46	FUCHS DEA Reniso SP 32 CHEVRON Zerol 150 MOBIL SHC 425 SUNOIL Suniso 3 GS TEXACO Capella WF 32
For FZX 16 / 2051 - R 404 A and FZX 16 / 2051 - R 410 A	
Bock standard oil grade	**Recommended alternatives**
FUCHS DEA Reniso Triton SE55	FUCHS DEA Reniso Triton SEZ 32 ICI Emkarate RL 32 H, S MOBIL Arctic EAL 32

Other suitable oil types on request.

Table 2

13. Technical data, dimensions and connections

13.1 Technical data

Technical data	Dim.	FZ 16 / 2051 - R 22	FZX 16 / 2051 - R 404 A	FZX 16 / 2051 - R 410 A
No. of cylinders		6		
Cylinder bore	dia. mm	80		
Piston stroke	mm	68		
Theoretical flow rate LP stage at 1450 rpm	m^3/h	118.9		
Theoretical flow rate HP stage at 1450 rpm	m^3/h	59.5		
Lubrication				
Forced circulation lubrication		Oil pump, independent of direction of rotation		
Oil grade for R 22		FUCHS DEA Reniso SP 46		
Oil grade for R 404 A, R 410 A		FUCHS DEA Reniso Triton SE 55		
Oil filling	litres	5.0		
Compressor belt pulley				
Outer diameter	mm	322		
V-belt profile, DIN 7753		SPB		
No. of grooves		5		
Speed range				
Min. speed	rpm	1400		
Max. speed	rpm	1800		
Max. permissible operating pressure				
Pressure side HP	bar	25		
Low pressure side LP	bar	19		

Table 3

13.2 Dimensions

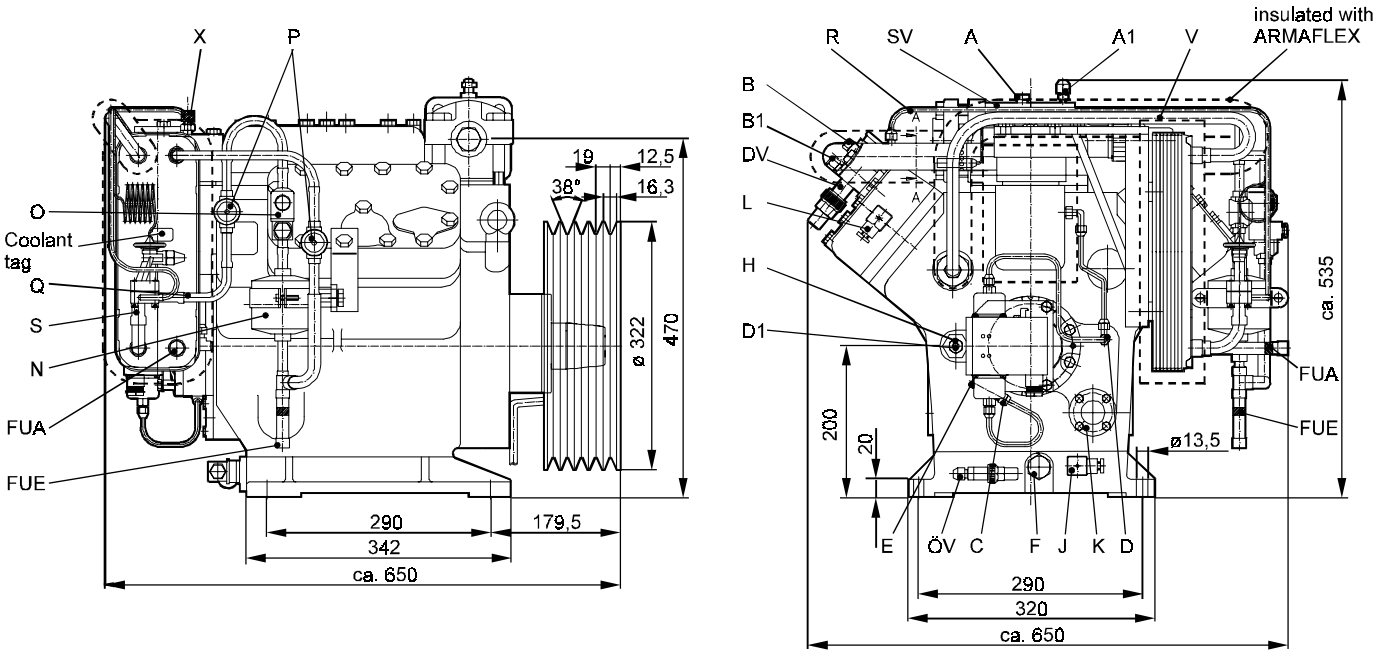


Fig. 19

13.3 Connections

Connections		Dim.	FZ 16/2051-R22	FZX 16/2051-R404A	FZX 16/2051-R410A
SV	Suction shut-off valve, pipe dia. (L)*	mm - inch	54 / 2 1/8"		
DV	Pressure shut-off valve, pipe dia. (L)*	mm - inch	36 / 1 3/8 "		
FUE	Liquid subcooler IN L*	mm - inch	16 / 5/8"		
FUA	Liquid subcooler OUT L*	mm - inch	16 / 5/8"		
A	Suction side connection, cannot be shut off	inch	1/4" NPTF		
A1	Suction side connection, can be shut off	inch	7/16" UNF		
B	Pressure side connection, cannot be shut off	inch	1/8" NPTF		
B1	Pressure side connection, can be shut off	inch	7/16" UNF		
C	Oil pressure safety switch connection HP	inch	7/16" UNF		
D	Oil pressure safety switch connection LP	inch	7/16" UNF		
D1	Connection for oil return from oil separator	inch	7/16" UNF		
E	Oil pressure gauge connection	inch	7/16" UNF		
F	Oil drain plug (oil filter)	mm	M 26 x 1.5		
H	Oil inlet plug	mm	M 22 x 1.5		
J	Oil sump heating	mm	M 22 x 1.5		
K	Con. oil/gas compensation for compound operation	mm	Cu-Pipe dia. 35		
L	Heat protection thermostat connection	inch	1/8" NPTF		
N	Filter drier L*	mm	2 x dia. 12		
O	Solenoid valve L*	mm	2 x dia. 12		
ÖV	Oil drain valve	inch	7/16" UNF		
P	Sight glass L*	mm	2 x dia. 12		
Q	Reinjection valve inlet L*	mm/inch	dia. 12 / 3/8"		
R	Pressure balance line for injection valve	inch	2 x 7/16 UNF		
S	Reinjection valve outlet L*	mm/inch	dia. 16 / 5/8"		
V	Reinjection pipe	inch	7/8" UNF; dia. 16 / 5/8"*		
X	Scrader connection for middle pressure gauge	inch	7/16" UNF		

*) L = soldered connection

Table 4